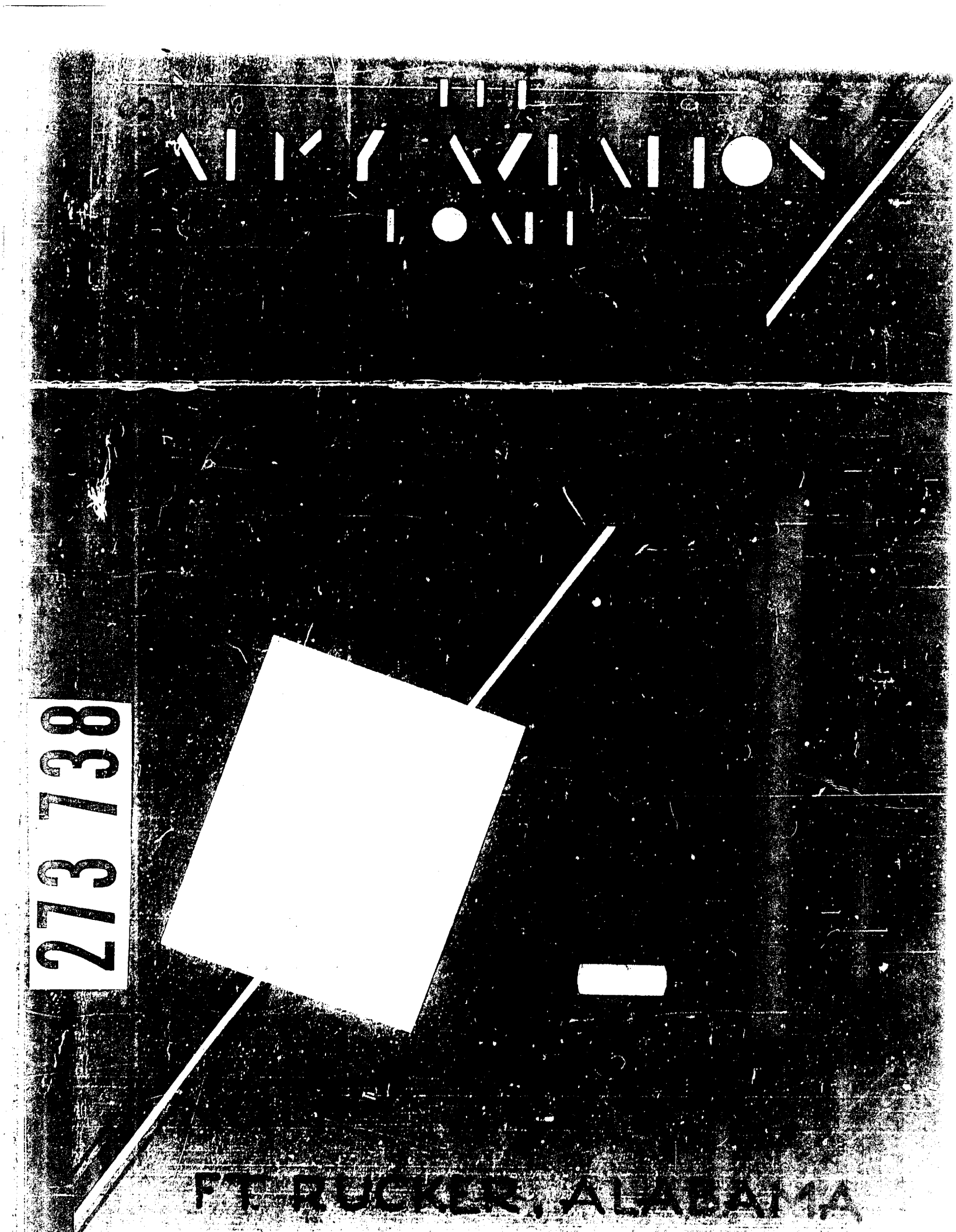
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UNITED STATES ARMY AVIATION BOARD
Fort Rucker, Alabama

REPORT OF TEST 27 FEB 1962

PROJECT NO. AVN 362

EVALUATION OF THE 2.75-INCH (MODIFIED) AERIAL ROCKET WEAPONS SYSTEM (H-34)

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1. AUTHORITY.

a. Directive. Letter, ATDEV-6 471.94, Headquarters, USCONARC, 7 July 1961, subject: "Evaluation of the 2.75-Inch (Modified) Aerial Rocket Weapons System."

b. Purpose. To conduct an evaluation of the 2.75-Inch (Modified) Aerial Rocket Weapons System as mounted on an H-34 helicopter to determine its suitability to meet the Army's requirement for helicopter area fire missions (Mission III requirement).

2. REFERENCES.

A list of references is contained in appendix C.

3. BACKGROUND.

a. Statement of Requirement. The following is quoted from paragraph 37a(2) of the Combat Development Objectives Guide: "A series of armament systems capable of rapid mounting and demounting on Army helicopters. The armament system may consist of weapons and ammunition from current weapons systems of advanced design, nuclear and non-nuclear, together with synchronized sighting, mounting, and firing devices providing for elevation, depression, and traverse where required. Mountings will be provided to permit attachment of various combinations of weapons to fit the mission. The systems will be employed as elevated firing platforms in support of offensive and defensive ground combat operations. The systems will provide for full

utilization of new weapons and ammunition and the maneuverability of Army helicopters."

b. General.

(1) The Army's capability for launching rockets from helicopters has been limited to those equipped to fire 4.5-inch rockets for demonstration and training purposes. Adoption of the 4.5-inch rocket for Army use from helicopters was not advisable due to the weight imposed by the rocket system, the limited supply of rockets, and the fact that the rockets are no longer in production. Ordnance Corps investigations revealed that the 2.75-Inch Folding Fin Aircraft Rocket (FFAR) offered the best potential for providing an immediate helicopter rocket-firing capability. This rocket is lighter in weight than the 4.5-inch rocket, is in production, and is a standard item of supply for the US Air Force, Navy and Marine Corps.

(2) The 2.75-inch aircraft rocket was designed to be launched from a high-performance airplane. To insure rocket stability immediately upon leaving the rocket pod, the rocket requires a higher aircraft speed than that attained by current Army helicopters. Since the helicopter does not have this speed capability, it was necessary to modify the rocket to obtain a spin in order to achieve stability upon launch by averaging thrust misalignment. Tests by the US Navy indicate that the zero-airspeed launch dispersion of 40 - 50 mils experienced with the standard rocket was reduced to 10 - 12 mils by this nozzle-scarfing modification.

(3) During April 1961, two hundred 2.75-inch (modified) aerial rockets were evaluated by Aviation Board personnel in coordination with Ballistic Research Laboratories (BRL), Aberdeen Proving Grounds, using an H-21 helicopter as the weapons platform. Results of the evaluation verified that the modified 2.75-inch aerial rocket is suitable for use as helicopter armament.

(4) An H-34 (serial number 56-4299) assigned to the Aviation Board was equipped with a 2.75-inch rocket system which was developed and fabricated by the Army Ordnance Missile Command (AOMC), Redstone Arsenal, Alabama. The equipment was received 28 August 1961. A maintenance package was not provided.

(5) A 2.75-Inch (Modified) Aerial Rocket Weapons System is under development for the HU-1B helicopter.

4. DESCRIPTION OF MATERIEL. The 2.75-Inch (Modified) Aerial Rocket Weapons System as installed on the test helicopter consists of the following:

a. Helicopter Modification Kit. The modification kit includes:

(1) Fire-Control Panel. This panel is located at the bottom center of the instrument panel and is readily accessible to pilot and copilot. There are four toggle switches on the panel; however, only two of these switches were required for the test installation: the master armament switch and the rocket switch. Activation of each switch is indicated by separate amber lights.

(2) Intervalometer. The control head of the intervalometer projects through the fire-control panel. Two toggle switches and a knob are provided as controls. One switch is used for selection of modes of fire - automatic or manual; the other switch is for jettison of the rocket pods. The knob permits selection of the initial pair of rockets to be fired within the range of one to twenty-three. With the selector switch in the automatic position, the intervalometer provides for firing pairs of rockets at 100 millisecond intervals while the trigger is depressed. A counter is also provided to indicate the number of pairs of rockets fired.

(3) Sight. The sight used in this test is a standard US Navy Mark 17 Sight with an illuminated optical reticle. The sight is installed close to the windshield in front of the pilot.

(4) Cyclic Trigger Switch. A thumb-actuated switch is installed in place of the hoist "up-down" switch on the top rear of the cyclic grip. Depression of this switch completes the electrical circuit for firing the rockets in the mode selected.

(5) Hardpoints and Bracketing. The rocket-pod-suspension frame is attached at hard points on either side of the helicopter. The lower attaching points require replacement of the original sling attaching brackets with brackets modified to incorporate an attaching lobe. The upper forward attaching points require removal of the

existing steps and replacement with steps modified to incorporate two attaching lobes. The upper rear attaching points are additions to the helicopter structure, are located on station 167, and are connected by a tension-compression member which passes through the cargo compartment approximately 50 inches above the floor. This member is designed to eliminate stresses on the sides of the helicopter.

b. Rocket-Pod-Suspension Frame. The rocket-pod-suspension frame is mounted on each side of the helicopter, is constructed of lightweight tubular aluminum, and can be rapidly mounted and dismounted from the attaching brackets. The suspension frame is fitted with a bomb rack at the rocket-pod-attaching point, which provides a rapid means of mounting, dismounting, and jettisoning the pod.

c. Bomb Rack. The bomb rack utilized with this installation is a type MA-4A with a rated capacity of 2000 pounds and a 14-inch span between attaching points.

d. Rocket Pod. The rocket pod is a 24-tube modular pod which consists of four six-tube modules. Each module is attached by steel pins to the adjacent module(s). The entire pod is then hung by an adapter bracket to the bomb rack on each side of the helicopter. Pod elevation of five degrees above the helicopter waterline is instituted by the bomb rack. The pod is wired to the fire-control panel and trigger through a cannon plug on the skin of the aircraft which is part of the helicopter modification kit.

e. 2.75-Inch (Modified) FFAR. The 2.75-inch FFAR is a standard Navy Type Mark IV Mod VI which has been modified to impart a ballistic spin of approximately five revolutions per second by scarfing the thrust nozzles at a 24-degree angle. This modification imparts sufficient spin to the rocket to average out thrust misalignment and stabilize the rocket with the assist of the extended fins. The rocket measures 48.7 inches in length and 2.75 inches in diameter, and weighs 18.1 pounds. It is available with HE and AT warheads.

5. SUMMARY OF TESTS. The 2.75-Inch (Modified) Aerial Rocket Weapons System mounted on an H-34 helicopter was evaluated by the Aviation Board during the period 27 September 1961 to 21 January 1962. Technical assistance was furnished by AOMC.

a. The system was found to be compatible with the H-34. The total weight of this system with 48 rockets was 1350 pounds. Center of gravity was not adversely affected, and no control problems or unusual flight attitudes were evident.

b. The system proved to be trouble-free throughout the test and appeared to be durable enough for sustained use under tactical conditions.

c. The system when fired during forward flight was accurate. Firing of a full complement of rockets resulted in an impact area measuring approximately 40 x 400 meters at an opening range of 1500 meters from an absolute altitude of 150 to 200 feet and 70 knots IAS. As with any fixed helicopter-mounted weapons system elevated for in-flight firing, hover fire was difficult and resulted in inaccuracies.

d. Arming and firing controls were generally satisfactory. However, the intervalometer provided with the system allowed only 46 of the complement of 48 rockets to be fired; one rocket in each pod could not be fired. In addition, the numbers on the intervalometer counter were not readily distinguishable. The thumb-actuated trigger switch used in this evaluation was unsatisfactory and should be forefinger-actuated.

e. A two-hour period of ground instruction and in-flight firing of at least 144 rockets should be sufficient to train an aviator/gunner to employ the system effectively. The helicopter crew chief required 16 hours of on-the-job training in system functioning, safety precautions required, rocket handling, and care and cleaning of the system.

f. The system did not require repair during test. Maintenance was limited to care and cleaning.

g. Deficiencies and shortcomings are listed in appendix B.

6. DISCUSSION.

a. The 2.75-Inch Aerial Rocket Weapon System, mounted on the H-34, was conceived, designed, and fabricated with a view toward

giving the Army an immediate field capability for helicopter armament on helicopters currently in use throughout the military system. The Aviation Board has recommended that a program be initiated to permit funding of this weapon system; however, to date this project has not been formally established by the Weapons Systems Management Office of the Transportation Corps. Without formal recognition, funds cannot be allocated nor authority granted to accomplish:

(1) Safety-of-flight certification by appropriate agencies beyond that required for test purposes.

(2) Compilation of handbook information.

(3) Refinement of this system beyond its present configuration.

(4) Initiation of production engineering.

(5) Development of production-type drawings.

b. The introduction of aircraft armament systems into the aviation program will require establishment of enlisted Aviation Armament Repairmen in the MOS structure. These specialists will be required to have a thorough knowledge of the requirements for handling, storage, and loading of aircraft rockets, missiles, and other ammunition. They must have knowledge of aircraft electrical and hydraulic systems in order to effect necessary repairs to the weapon fire-control system. It will be the responsibility of these specialists to test and insure the proper functioning of all aircraft weapon systems within an organization. The specialists will advise and supervise the aircraft crewchief on proper first- and second-echelon weapons system maintenance procedures and have a thorough knowledge of ordnance security requirements and administrative records.

c. Although the 2.75-Inch FFAR is a standard item of Ordnance for use by the US Air Force, Navy, and Marines, this Board has been advised that the rocket modified for low-speed launch cannot be considered a standard item. Based on tests of this modified rocket by the US Navy, the tests performed by the Ballistics Research Laboratory (BRL), Aberdeen Proving Grounds,

and this Board's experience, this Board has recommended (reference 5) that the modified 2.75-inch rocket should be considered for type classification without further extensive engineering tests.

7. CONCLUSIONS.

a. The 2.75-Inch (Modified) Aerial Rocket Weapons System mounted on the H-34 offers an immediate capability to fullfill the Army's requirement for an area fire weapons system.

b. A requirement exists for an Army Aviation Armament Repairman at the organizational level.

8. RECOMMENDATIONS. It is recommended that:

a. Deficiencies and shortcomings listed in appendix B be corrected.

b. After the deficiencies listed in appendix B are corrected, the 2.75-Inch (Modified) Aerial Rocket Weapon System be type-classified Standard A for use on the H-34 helicopter. (This item will not replace any similar system.)

c. The first production system be furnished the US Army Aviation Board for confirmatory test.

d. A formal training program be established immediately to qualify enlisted personnel in the maintenance of aircraft armament systems.

e. Upon successful completion of training indicated in paragraph d above, a new MOS be awarded for an Army Aviation Armament Repairman.

f. The 2.75-Inch (Modified) Folding Fin Aircraft Rocket be type-classified Standard A without further extensive engineering tests.

LT COL

FOR JACK L. MARINELLI
Colonel, Artillery
President

APPENDIX A

DETAILS OF TEST

Figure 1 - The 2.75-Inch Aerial Rocket Weapons System as mounted on an H-34 Helicopter

DETAILS OF TEST

I. SCOPE. The 2.75-Inch (Modified) Aerial Rocket Weapons System mounted on an H-34 helicopter was evaluated by the US Army Aviation Board with technical assistance furnished by the AOMC, Huntsville, Alabama. Testing was conducted at Fort Rucker, Alabama, and Fort Sill, Oklahoma, during the period 27 September 1961 to 21 January 1962. A total of 464 rockets was fired during the evaluation. Temperatures during the evaluation ranged from 8°F. to 92°F.

II. TESTS.

1. General Characteristics.

a. Dimensions, Weight, and Power Requirements.

(1) Dimensions (Inches):

Width of pod	22
Lenght of pod	49 3/4
Depth of pod	15
Ground clearance at lowest point of the pod	58
Helicopter centerline to outer edge of pod	113

(2) Weights (Pounds):

Cabling, fire-control panel, sight w/bracket, and intervalometer	35
Two suspension frames with attaching brackets and bomb racks.	160

Two modular-pod 24-tube assemblies with adapter brackets.	286
Total weight (less rockets)	481
Weight of 48 rockets	869
Total weight (with 48 rockets)	1,350

b. Physical Compatibility with the Helicopter. The test weapons system was found to be compatible with the H-34. Prior to in-flight firing tests, the following was accomplished:

(1) Stresses and loads were applied by AOMC engineers to the structure, simulating "worst possible load" conditions which might be encountered in flight. Results indicated that the structure of the system is adequate for all loads and stresses expected to be encountered in the flight envelope.

(2) During flight testing, the system was fully instrumented by AOMC technicians, and no unusual vibrations or stresses were found during any flight or firing maneuvers with exception of tension-compression member vibration. AOMC fabricated a replacement member of tubular aluminum which eliminated the vibration problem. (see figure 7)

(3) To determine whether a lateral center-of-gravity problem could develop, a weight of 605 pounds was suspended alternately from the bomb rack on either side of the helicopter to simulate a full rocket pod which could not be jettisoned. Weight and balance calculations indicated a 7.8-inch shift in the lateral center of gravity. A slight displacement (less than eight degrees) of the cyclic control toward the unloaded side was experienced. However, no restrictions of control or unusual flight attitudes were noted during hover flight, to include 360-degree hovering turns with an eight-knot wind, or during flight maneuvers at indicated airspeeds up to 30 knots. Test was not conducted at higher airspeeds since stability increases with speed.

(4) Since this weapons system was mounted on the helicopter with its mass centered on the rotor mast, there was no effect on the longitudinal center of gravity of the helicopter.

c. Jettison Capability. The jettison capability was tested, and functioning was satisfactory with the 605-pound weight suspended from either shackle.

d. Cockpit Arrangement of Sight and Arming and Firing Controls. The arrangement of sighting and arming controls was considered adequate except for the trigger switch (see paragraph 2d).

e. Ruggedness. The system proved to be trouble-free throughout the test and appeared to be durable enough for sustained use under tactical conditions. (See paragraph b(1) above)

2. Operational Characteristics.

a. Static Firing. Firing tests were initiated by firing single pairs of rockets statically from the ground and gradually increasing the number of rockets fired up to 46 (see paragraph d(2) below) at ripple-rate spacing of 100 milliseconds. No problems were encountered.

b. Capability and Reliability of the System During Normal Flight Maneuvers. In-flight firing was conducted at airspeeds from hovering flight to 110 knots indicated airspeed with no unusual effects.

(1) Firing from a hover with this system was relatively difficult and inaccurate. Since this was a fixed system and the helicopter flies with approximately 1 1/2 degrees nose-down attitude at 70 knots, the pods are elevated five degrees above the helicopter waterline to impart a quadrant elevation of 3 1/2 to 4 degrees to the rocket tubes, thus permitting ranges to 2000 meters. Because of the two-to-four-degree tail-low hover attitude of the H-34 and the five-degree elevation built into the pods, an effective quadrant elevation of +7 to +9 degrees resulted. This condition required the pilot to pitch the nose of the aircraft downward and to fire as the sight passed through the target, thus making sighting corrections almost impossible.

(2) Accuracy of this system when fired during forward flight was excellent. Seventy knots' indicated airspeed was found to give maximum stability to the platform while also giving a

Figure 2 - Static firing

range capability of 2000 meters when fired from absolute altitude of 150 to 200 feet. Impact patterns showed excellent area coverage, with the initial pair of rockets impacting approximately 10 - 20 meters apart and succeeding pairs impacting at approximately 15 meters greater range with the same lateral spacing. Employing a ripple of 46 rockets, a beaten zone of approximately 40 x 400 meters resulted at an opening range of 1500 meters from 150 to 200 feet absolute altitude and 70 knots indicated airspeed (IAS).

(3) During normal functioning of this system, a rocket is launched simultaneously from each side of the helicopter. To determine helicopter reaction to pod malfunction, failure of the firing circuit to the pod on the left side was simulated by loading only the pod on the right side. Helicopter reaction to a 23-rocket ripple, with 100 millisecond spacing between rockets at 70 knots airspeed, was manifested by a very slight yaw to the right. Accuracy was only slightly affected as the yaw did not fully assert itself until after the complement had departed the helicopter (2.3 seconds).

c. Reloading and Turn-Around Time.

(1) With assembled rockets pre-positioned on each side of the helicopter, four men could load and secure all 46 rockets in 12 minutes.

(2) Turn-around time and reloading time were synonymous for this weapon system; however, aircraft provisioning and maintenance may extend turn-around time.

d. Suitability of the Arming and Firing Controls.

(1) The fire-control panel was considered adequate.

(2) The 24-station intervalometer was not suitable as one station could not be used, and a total of only 46 rockets could be fired. The intervalometer counter was almost impossible to read and did not indicate the number of rockets remaining to be fired.

(3) The thumb trigger was not suitable as the trigger switch should be forefinger-actuated.

(4) A selector was not incorporated to permit the pilot to preselect the number of pairs of rockets to be fired in a ripple.

e. Suitability of the Sight. The Mark 17 sight utilized in this test was found to be adequate; however, a slip indicator on the sight would facilitate the sighting operation, especially in a cross-wind. The sight was adjustable in deflection and elevation, which permitted rapid harmonization with the launcher tube. The reticle was sufficiently

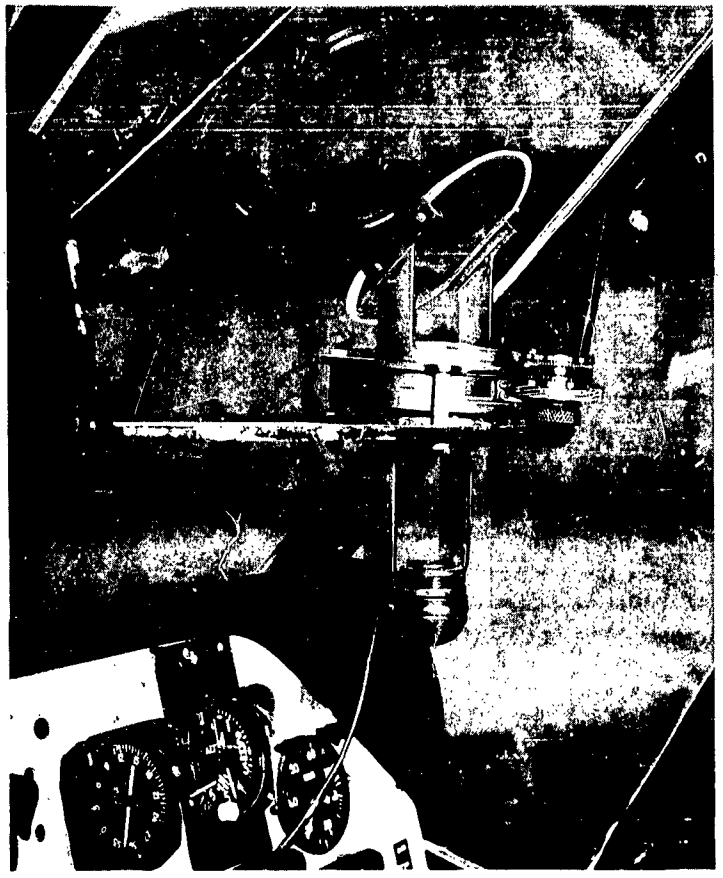

Figure 3 - Mark 17 Mod O Sight used in evaluation with locally fabricated mounting bracket

bright to be easily visible under all daylight conditions encountered; considerable reduction of intensity would be required for night operation.

f. Suitability of the Rocket Pod. The 24-tube modular pod was suitable for field use. No problems were encountered with the pod during the test.

g. Noise Level, Gas Contamination, and Effects of Rocket Blast and Flash.

(1) The noise level was acceptable. Firings were conducted by the crew members with and without benefit of the APH-5 helmet, and no discomfort was experienced.

(2) Fumes from launching rockets were noticeable inside the helicopter during firing. Tests conducted with a carbon monoxide (CO) indicator, however, showed no increase in CO concentration above that normal to the helicopter in flight (15 parts per million), and the crew suffered no discomfort or ill effects from exposure. Fumes dissipated rapidly when doors and windows were opened after firing.

(3) Debris from the rocket motors did not affect the skin and plexiglas of the helicopter.

h. Adequacy of the Ammunition Load. The ammunition load of 48 rockets was considered adequate.

3. Safety Provisions and Required Precautions. Normal range safety precautions were observed throughout the test. In addition, the following precautions are particularly applicable to this system:

a. All armament switches should remain in the OFF position until ready to fire to avoid possibility of inadvertent firing.

b. Personnel on the ground should be alert to the dangers of passing in front of and behind the rocket system.

c. During all loading operations, to preclude ignition of rockets by stray voltage or static electricity, the aircraft battery should be disconnected, all switches cut off, and the helicopter grounded to a metal rod imbedded at least one foot in the ground.

d. Firings should be conducted with doors and windows closed. Debris from the rocket motors could cause irritating burns on exposed skin and clothing of the crew.

e. Firing over areas where conditions are such as to create possible hazard to persons or property on the ground should be avoided. Grass fires could be started under the launch point by the same debris mentioned in d above.

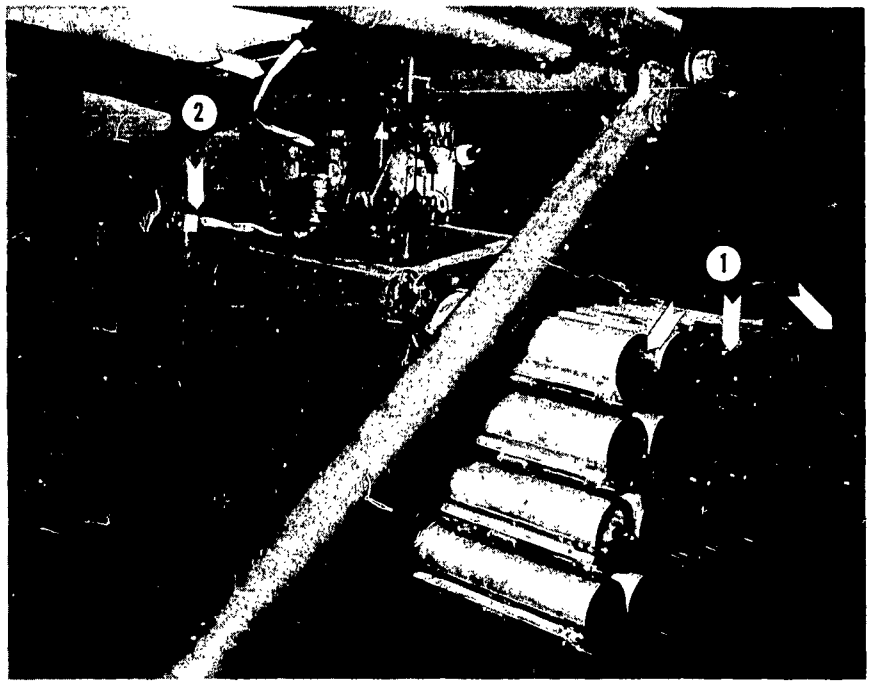

Figure 4 - Inside view of launcher pod and bomb rack showing (1) ignition contacts on after end of tubes and (2) rocket ignition wiring to pod

4. Personnel.

a. Flight.

(1) A two-hour period of ground orientation on rocket firing and safety precautions, followed by in-flight firing of three complete loads of rockets should be sufficient to train an aviator/gunner

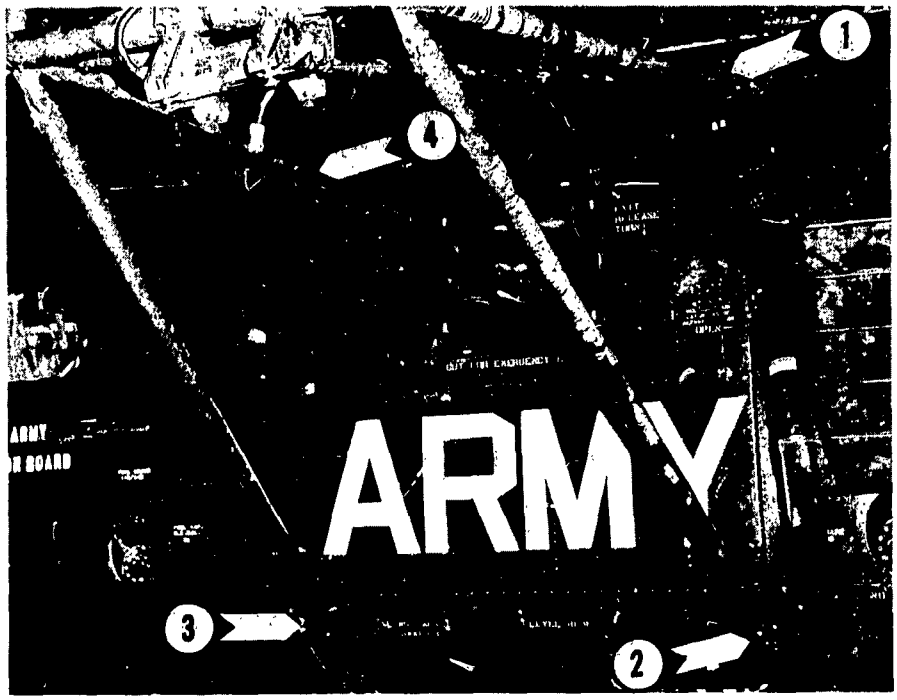

Figure 5 - Right side suspension frame and attaching brackets. Attaching points (1), (2), and (3) are modifications of bracketry existing on all H-34's; attaching point (4) is an addition to airframe.

to employ this system effectively. However, insufficient rockets were available to assess the actual training requirements.

(2) The helicopter crew chief required approximately 16 hours of on-the-job training in system functioning, safety precautions required, rocket handling, and care and cleaning of the weapons system.

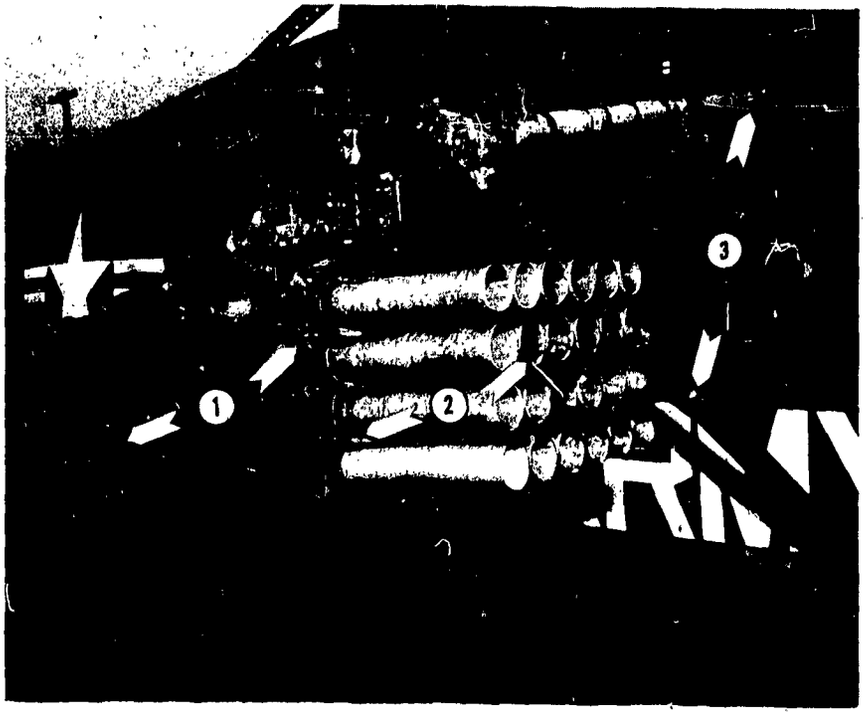

Figure 6 - Launcher pod and bomb rack showing (1) pins used to connect modules and adapter bracket, (2) corrosion on forward portion of the pod, and (3) condition of paint on suspension frame.

b. Maintenance. An Ordnance Small Arms Repairman, E-6 (MOS 421.6), with over three years' experience on experimental helicopter armament systems while assigned to the 8305th Aerial Combat Reconnaissance Company (X) at Fort Rucker, Alabama,

was present throughout the test. The extensive knowledge of this enlisted man permitted him to check the system thoroughly for continuity prior to firing tests and to supervise handling of the rockets and performance by the crew chief of preventive maintenance such as cleaning the rocket pod and dressing contact points on the rocket pod and inside the intervalometer. Although no repair of this system was necessary during the evaluation, the experience of this individual would have probably permitted him to effect repairs without inordinate delays. Had this experience not been available during the test, availability of at least one technician from AOMC would probably have been required during all firing phases.

5. Maintenance.

a. A maintenance package was not received with this installation. Post-firing maintenance consisted of washing the launcher pods with hot soapy water. Corrosion of the launcher tubes occurred after firing. This condition has been referred to AOMC for recommendations as to preventive measures.

b. The pod suspension frame was not painted in accordance with regulations and therefore required excessive spot painting.

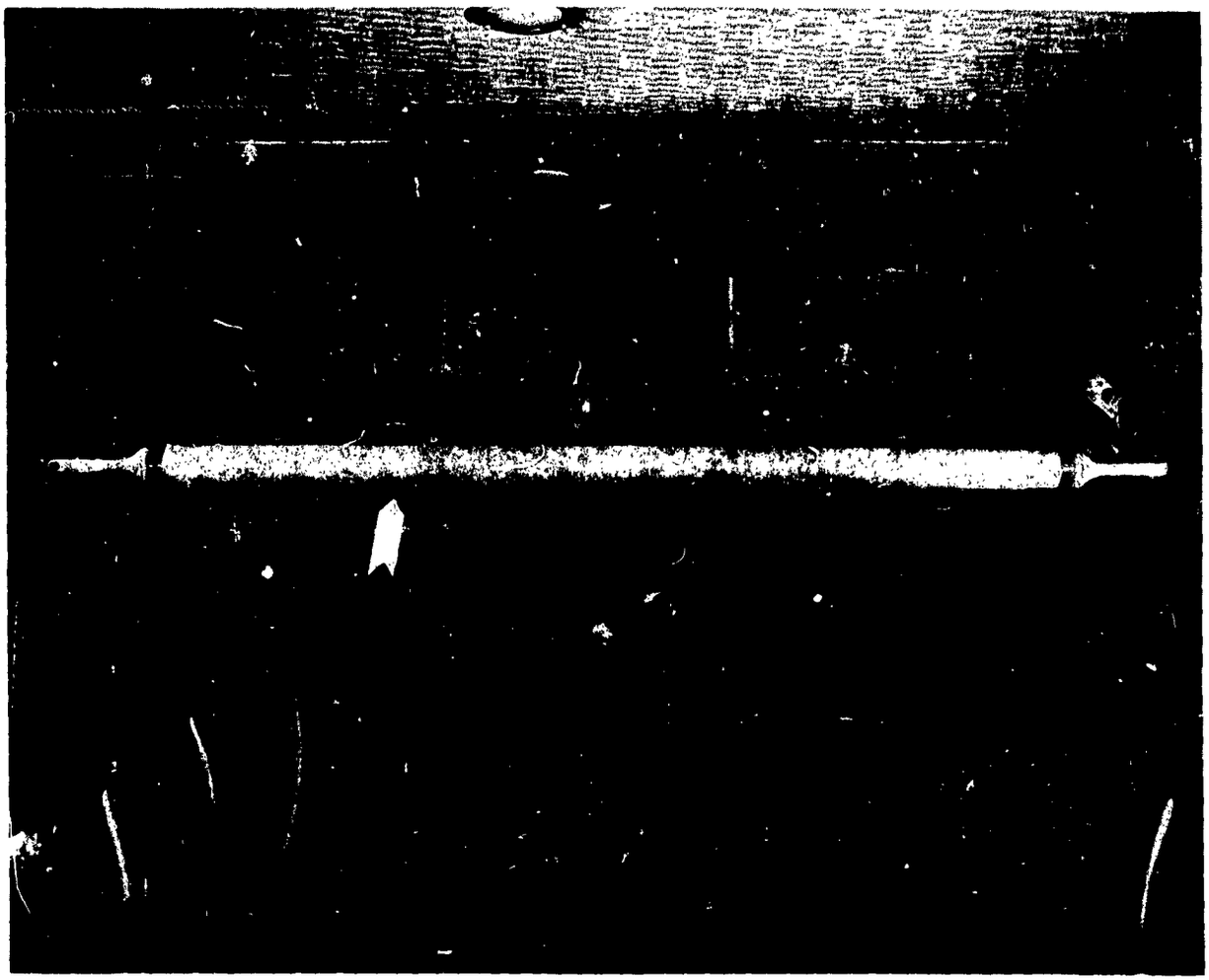

Figure 7 - Tension-compression member

APPENDIX B

FINDINGS

FINDINGS

This appendix includes all deficiencies and those shortcomings which are considered significant enough to warrant corrective action.

Section I

This section contains deficiencies requiring elimination in order to make the item acceptable for use on a minimum basis.

Deficiency	Suggested Corrective Action	REMARKS
1. Intervalometer permits firing of only 23 rockets per pod.	Provide intervalometer capable of firing the full pod.	In interest of standardization, consideration should be given to the use of the same intervalometer, if it proves suitable, to be utilized on the HU-1B/2.75-inch aerial rocket weapons system.
2. Trigger switches are positioned for actuation with the thumb.	Utilize a switch on the cyclic grip which is actuated by pressure of the forefinger.	Use of the forefinger on the trigger is desirable from the human engineering standpoint.
3. The numbers on the counter of the intervalometer are not readily distinguishable.	Provide counter with numbers at least 1/4" high with contrasting background.	

Section II

This section contains shortcomings which should be corrected, if it can be done without unduly complicating the item or inducing another undesirable characteristic, either concurrently with elimination of deficiencies in section I, or in production engineering, or by product improvement.

Shortcomings	Suggested Corrective Action	Remarks
1. Intervalometer counter indicates number of pairs of rockets fired.	Provide counter which reflects number of pairs of rockets remaining.	
2. There is no choice of selection of the number of rocket for ripple fire.	Provide for selection of 6, 12, or 24 pairs of rockets per ripple.	
3. Paint flakes off frame and pod.	Paint components in accordance with appropriate directive.	
4. Fire-control panel had an excessive number of switches.	Provide a panel designed for this weapons system.	
5. No slip indicator is provided on Mark 17 sight.	Provide a sight comparable to the Mark 17 sight which incorporates a slip indicator.	

APPENDIX C

LIST OF REFERENCES

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1. Paragraph 537a(2), Combat Development Objectives Guide, 15 December 1961.

2. Letter, ATDEV-6 400.114, Headquarters, United States Continental Army Command, 12 January 1961, subject: "USCONARC-Approved Military Characteristics for Armed Helicopter Weapons System (U)."

3. Letter, ATDEV-6, 471.94(C), Headquarters, United States Continental Army Command, subject: "Rockets for Armed Helicopter," w/1st Indorsement, CRD/H 14794, Office, Chief of Research and Development.

4. Message, ATAVN 307004, Commanding General, United States Continental Army Command, Confidential.

5. Message, ATBG-ACAR 11-83, United States Army Aviation Board, 6 November 1961.